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The Mineral Industry of Bolivia

UNITED STATES DEPARTMENT OF THE INTERIOR

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The Mineral Industry of Bolivia

By Pablo Velasco[1]

The mining sector historically has been the backbone of Bolivia's economic development and remains a major source of foreign exchange, tax revenues, and employment. Tin has been the country's most important mineral, providing more than 90% of the total nonfuel mineral export sales, with antimony, gold, lead, silver, tungsten, and zinc being the other important nonfuel minerals.

The year 1987 was a difficult one in the long history of Bolivia's mining industry. The real value of mine production was at its lowest level in 9 years, and employment fell drastically.

In a historic change, the state mining corporation, Corporación Minera de Bolivia (COMIBOL) was decentralized by Supreme Decree No. 21377. Today COMIBOL operates as a holding company with five autonomous subsidiary mining companies and two autonomous smelter enterprises. This reorganization replaced the former inefficient centralized administrative system that had directed and controlled more than 21 mining companies and 11 service subsidiaries.

Tin has become a commodity of reduced significance in the national economy, which it had dominated since 1900. However, at yearend there was an indication that the tin crisis, caused by a sharp drop in prices, was over, and the mineral industry was stabilized with prospects of a modest recovery in 1988 and years ahead.

The Bolivian economy expanded slightly in 1987 after 5 consecutive years of decline. Preliminary estimates indicate that the growth was slightly more than 2.0% relative to that of 1986. Rigorous economic measures imposed in mid-1985 succeeded in curbing hyperinflation and stabilizing the currency. However, low world market prices for Bolivia's hydrocarbons and mineral exports, as well as the restructuring of several state-owned enterprises, led to large-scale reduction of personnel in both the public and private sectors. Unemployment averaged 20% during 1987.

The Government's economic reactivation program, announced in July 1987, aimed to reform the banking system, promote exports, and create a climate more favorable to foreign investors. Nevertheless, as of late 1987 many of its proposals had yet to be implemented. Internal structural problems such as high transportation and credit costs continued to inhibit recovery and economic expansion.

Bolivia remained dependent on natural gas exports to Argentina for a large portion of its total export earnings. Hydrocarbons and nonfuel mineral exports accounted for 81% of the total export value. In 1987, the hydrocarbons sector contributed 44% of total exports; nonfuel minerals, 37%; and agriculture and others, 19%.

Government Policies and Programs.—The policy of the present Government is to create an environment in which individuals and private companies are free to search for new ore deposits, to invest in them, and to benefit from the effort and capital expended. New tax laws that support this policy are equitable for the investor, labor, and the country.

The restructured COMIBOL, as a holding company, is headed by a general board of directors that includes a president, two board members appointed by the President of Bolivia, and one board member appointed by the Miner's Union Federation (FSTMB). The general board of directors appoints COMIBOL's general manager and those of the subsidiary companies. The board of

directors approves COMIBOL's budget, delineates company policies, and approves and supervises the leasing contracts of the company's mining properties.

The five subsidiary mining companies under direct supervision of COMIBOL are Cía. Minera de Oruro (Oruro Mining Co.) responsible for the San José tin-silver mine, Huanuni tin mine, Bolivar tin-zinc silver mine, María Luísa tin mine, and Poopó tin mine; Cía. Minera de La Paz (La Paz Mining Co.) responsible for the Caracoles tin mine; Cía. Minera de Potosí (Potosi Mining Co.) responsible for the Unificada-del Cerro Rico de Potosí tin-silver mine and the La Palca tin fuming plant; Cía. Minera Quechisla (the Quechisla Mining Co.) responsible for the San Vicente zinc-silver mine, Chocaya tin mine, Tasna bismuth-gold mine, Tatasi lead-zinc-silver mine (it also will be in charge of the hydroelectric plant of Rio Yura and the Pulacayo mining equipment factory); and Cía. Minera del Oriente (the Eastern Mining Co.) responsible for the Mutún iron-manganese mine.

The two subsidiary smelting companies created with their own boards of directors and management were (1) the Complejo Metalúrgico de Vinto (the Vinto metallurgical complex), formerly Empresa Nacional de Fundiciones, in charge of one antimony and two tin smelters at Vinto near Oruro City; and the Complejo Metalúrgico de Karachipampa (the Karachipampa metallurgical complex), which will be in charge of the Karachipampa lead-silver-zinc smelter in the Potosí Department.

COMIBOL was authorized by the Government to lease some of its mining properties to cooperatives composed chiefly of former workers of the company. The cooperatives will pay COMIBOL a rent of at least 1% of the net value of the minerals produced, and the lease contract will be for a minimum of 5 years and up to a maximum of 10 years. COMIBOL was authorized to rent the Catavi tin mine, the Colquiri tin mine, the Colquechaca tin-silver mine, the Japo tin mine, the Santa Fé tin mine, the Morococala tin mine, the Viloco tin mine, and the Machacamarca beneficiation plant.

PRODUCTION

In 1987, the Bolivian mining industry experienced a profound structural change. The regulations implemented by the Government after the collapse of the tin market in October 1985 were directed toward the reestablishment of the mining industry to a higher level of competency within the context of a free economy without subsidies, but with some financial and foreign exchange constraints. After 5 years of economic recession in the country, a new expansion cycle appeared to have begun. The volume of mining output increased by 25% in 1987 compared with that of 1986. The reactivation program produced more diversification in the mining sector with increased output of precious metals. The medium-size mining sector was the major factor in this improvement. In contrast, COMIBOL's production fell by about 59% compared with that of 1986, owing to the closure of several unprofitable tin mines during the first half of the year in accordance with the Government's rehabilitation guidelines.

Tin production by sectors during 1987 showed COMIBOL with a sharp decline of 91% to 384 tons compared with that of 1986, the lowest output ever registered by this state-owned corporation. This compares with COMIBOL's record high tin output of 33,740 tons in 1977. In 1987, COMIBOL's output of tin represented only 5% of the total. The medium-size mines accounted for 28%, and the small-size mining sector and cooperatives accounted for 67% of the total.

Other important mineral commodities produced in 1987 included silver, which emerged as the country's second most important mineral with an increase of 47%, followed by lead, 190%; zinc, 17%; and gold 261%. The expansion in gold production was due to a decrease in illegal sales to neighboring countries, to better prices offered by the Banco Minero de Bolivia (BAMIN) and private buyers, and to a favorable exchange rate. The level of gold obtained by the BAMIN agency was approximately 2.7 tons, which almost equals the production capacity of the country.

Table 1.—Bolivia: Production of mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity[2]	1983	1984	1985	1986[p]	1987[p]
METALS[3]					
Antimony:					
Mine output, Sb content	9,951	9,281	8,925	10,243	10,635
Metal	r4,192	r861	762	1,171	1,723
Arsenic, mine output, arsenic trioxide, arsenic sulfide	107	144	361	241	132
Beryllium: Beryl concentrate:					
Gross weight	--	--	--	--	42
Be O content	--	--	--	--	3
Bismuth, mine output, Bi content	5	3	159	45	1
Cadmium, mine output, Cd content[4]	143	124	104	36	15
Copper, mine output, Cu content	1,982	1,610	1,665	338	9
Gold, mine output, Au content[5] troy ounces	49,217	40,827	e30,000	24,531	88,585
Iron ore:[6]					
Gross weight[e]	10,939	256	--	17	11
Fe content	7,001	4	--	11	7
Lead:					
Mine output, Pb content	11,838	7,448	6,242	3,121	9,043
Metal including alloys	301	185	231	182	201
Manganese ore:[6]					
Gross weight[e]	61	--	--	(7)	--
Mn content	28	--	--	(7)	--
Silver, mine output, Ag content thousand troy ounces	6,025	4,560	3,580	3,058	4,508
Tin:					
Mine output, Sn content	25,278	19,911	16,136	10,479	8,128
Metal, smelter	14,164	15,842	12,859	7,673	2,610
Tungsten, mine output, W content	2,449	1,893	1,643	1,095	638
Zinc, mine output, Zn content	47,132	37,770	37,110	33,472	39,122
INDUSTRIAL MINERALS					
Barite	516	984	1,282	129	1,337
Calcite	165	e150	23	300	600
Cement, hydraulic	327,360	285,600	379,500	295,200	396,017
Gypsum, crude[e]	750	700	700	r700	700
Salt[e]	10,000	10,000	10,000	10,000	10,000
Sulfur	3,010	1,878	2,741	4,730	8,746
MINERAL FUELS AND RELATED MATERIALS					
Gas, natural:					
Gross million cubic feet	178,059	173,206	164,118	160,858	161,197
Marketable do.	78,652	78,047	78,255	78,161	74,879
Natural gas liquids:					
Natural gasoline thousand 42-gallon barrels	728	601	593	540	514
Liquefied petroleum gas do.	509	1,136	1,460	1,406	2,097
Petroleum:					
Crude do.	8,100	7,621	7,245	6,956	6,890
Refinery products:					
Gasoline do.	2,917	2,728	2,784	2,988	3,318
Jet fuel do.	569	548	573	587	547
Kerosene do.	647	653	578	358	360
Distillate fuel oil do.	1,544	1,496	1,489	1,958	2,108
Residual fuel oil do.	928	727	535	474	222
Lubricants do.	115	74	67	107	107
Liquefied petroleum gas do.	475	1,712	1,788	542	473
Unspecified do.	550	20	12	66	73
Refinery losses[8] do.	66	87	8	5	348
Total do.	7,811	8,045	7,834	7,085	7,556

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through June 1988.

[2]In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, crushed and broken stone, and dimension stone) are produced, but available information is inadequate to make reliable estimates of output levels.

[3]Unless otherwise specified, data represent actual production by Corporación Minera de Bolivia (COMIBOL) and small- and medium-size mines.

[4]Cadmium contained in zinc concentrates produced by COMIBOL. (Cadmium is not recovered in elemental form in Bolivia.)

[5]Small- and medium-size mines output sales to Banco Minero de Bolivia (BAMIN) and COMIBOL exports (small- and medium-size mines cannot legally export gold).

[6]Data represent exports and are regarded as being equal to production.

[7]Reported as zero.

[8]Refinery fuel not reported separately, if at all, in recorded data.

TRADE

Total exports decreased by 15% compared with that of 1986, due primarily to decreased revenues from minerals and hydrocarbon sales. Foreign exchange reserves dropped substantially in 1987, due in part to Argentina's delayed payments for natural gas purchases. Hydrocarbon sales to Argentina, which accounted for more than one-half of Bolivia's total legal exports, dropped by 30% compared with that of 1986. Total exports were estimated at $562 million[2] compared with $665 million in 1986. Nonfuel mineral export revenues increased 5% compared with those of 1386 to $207 million or 37% of the total exports. Natural gas contributed 44% or $249 million of the country's total export value, exceeding the nonfuel mineral export revenue for the fifth consecutive year. Tin, traditionally Bolivia's main export, totaled 10,105 tons valued at $69 million, a decrease of nearly 40% in volume and 34% in value relative to that of 1986.

Compared with that of 1986, exports of other nonfuel minerals such as gold increased in volume 278% and increased in value 366%. Lead decreased in volume 42% and decreased in value 15%, silver decreased in volume 3.4% but increased in value 22.1%, tungsten decreased in volume 19% and decreased in value 23%, and zinc increased in volume 11% and increased in value 17%. The European Economic Community accounted for 53% of the total export value of mining and metallurgical products and the United States, 27%. The remaining 20% was distributed among the European Free Trade Association, the Council for Mutual Economic Assistance, Asia, the Andean Pact, the Latin American Integration Association, and others.

Officially registered imports in 1987 totaled $776 million, an increase of 9% compared with that of 1986. Total exports to the United States declined 11% compared with that of 1986 to $113 million, while imports from the United States increased 26% over those of 1986 to $139 million. New currency was issued at the end of 1986.

Table 2.—Bolivia: Exports of mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity	1986	1987	Principal destinations, 1987
Antimony:			
Ore and concentrate	7,308	10,761	NA.
Trioxides	652	683	All to United Kingdom.
Metal including alloys:			
Regulus	50	652	Brazil 441; Spain 115; Colombia 48.
All forms	469	388	United Kingdom 253; Brazil 135.
Arsenic: Trioxides and other compounds	241	132	NA.
Barite and witherite	129	1,337	NA.
Beryllium: Ore and concentrate	--	42	NA.
Bismuth: Ore and concentrate	45	--	
Copper: Ore and concentrate	568	7	NA.
Gold:			
Ore and concentrate troy ounces	7,969	39,429	NA.
Metal including alloys, unwrought and partly wrought	r11,638	44,040	NA.
Iron and steel: Iron ore and concentrate	11	7	NA.
Lead:			
Ore and concentrate	12,886	7,436	NA.
Metal including alloys	--	8	All to Panama.
Manganese: Ore and concentrate	28	--	
Silver: Ore and concentrate thousand troy ounces	5,055	4,884	NA.
Sodium compounds, n.e.s.: Carbonate, natural	--	20	NA.
Sulfur, all forms	4,730	8,746	NA.
Tin:			
Ore and concentrate	8,618	8,255	NA.
Ash and residue containing tin kilograms	330	--	
Metal including alloys, all forms	8,609	2,096	Colombia 409; Chile 202; United States 158.
Tungsten: Ore and concentrate	1,504	1,220	NA.
Zinc: Ore and concentrate	35,572	39,639	NA.

rRevised. NA Not available.

[1]Table prepared by H. D. Willis. Table includes partial provisional export data. Import data for 1985-87 were not available at the time of publication.

Table 3.—Bolivia: Imports of mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity	1983	1984	Sources, 1984	
			United States	Other (principal)
METALS				
Aluminum:				
Oxides and hydroxides:				
value, thousands	$39	$34	$8	West Germany $12; Peru $2.
Metal including alloys:				
Unwrought	459	50	--	All from Brazil.
Semimanufactures	871	347	4	Brazil 209; Argentina 79; France 31.
Chromium: Oxides and hydroxides	--	1	--	All from West Germany.
Cobalt: Oxides and hydroxides:				
value, thousands	$3	$1	--	All from Argentina.
Copper: Metal including alloys:				
Unwrought do.	$3	$5	$2	Japan $3.
Semimanufactures	392	270	6	Peru 149; Brazil 55; West Germany 36.
Iron and steel: Metal:				
Scrap	11	--		
Pig iron, cast iron, related materials	401	112	--	Argentina 106; Brazil 6.
Ferroalloys:				
Ferromanganese	89	126	--	Brazil 93; Belgium-Luxembourg 33.
Unspecified	1,271	250	--	U.S.S.R. 205; Brazil 29; West Germany 16.
Steel, primary forms	338	81	--	Japan 77; Argentina 4.
Semimanufactures:				
Bars, rods, angles, shapes, sections	15,581	16,097	90	Argentina 6,247; Brazil 5,751; U.S.S.R. 1,178.
Universals, plates, sheets	17,332	8,626	463	Brazil 3,971; Japan 2,652; Chile 508.
Hoop and strip	280	163	(2)	Brazil 96; West Germany 67.
Rails and accessories	2,309	80	--	United Kingdom 41; Japan 21; France 14.
Wire	352	1,079	115	Argentina 477; Brazil 150; Chile 122.
Tubes, pipes, fittings	20,420	16,818	632	Argentina 7,412; Japan 4,310; Brazil 2,960.
Castings and forgings, rough	1,660	1,106	4	Peru 846; U.S.S.R. 168; United Kingdom 58.
Lead:				
Oxides	--	3	--	All from Peru.
Metal including alloys:				
Unwrought	1	10	5	Peru 5.
Semimanufactures:				
value, thousands	$2	$2	--	All from West Germany.
Magnesium: Metal including alloys, semimanufactures	1	--		
Mercury value, thousands	$4	$1	$1	
Molybdenum: Metal including alloys, all forms do.	$9	$1	--	All from Belgium-Luxembourg.
Nickel: Metal including alloys, semimanufactures do.	$33	$1	--	All from Argentina.
Platinum-group metals: Metals including alloys, unwrought and partly wrought do.	--	$1	--	All from West Germany.
Rare-earth metals including alloys, all forms	12	--		
Silver: Metal including alloys, unwrought and partly wrought:				
value, thousands	--	$2	--	Do.
Tin: Metal including alloys, semimanufactures do.	--	$1	--	All from Panama.
Titanium: Oxides	30	30	--	Finland 18; West Germany 7; Argentina 2.
Tungsten: Metal including alloys, all forms value, thousands	$34	$43	--	All from Netherlands.
Zinc:				
Ore and concentrate do.	$1	--		
Oxides	22	16	--	West Germany 13; Netherlands 2; Peru 1.
Metal including alloys:				
Unwrought	710	117	--	Peru 96; Brazil 21.
Semimanufactures	1	4	4	
Other:				
Oxides and hydroxides	28	113	--	Brazil 103; West Germany 9; Canada 1.
Ashes and residues:				
value, thousands	--	$2	$2	
Base metals including alloys, all forms	--	1	--	All from Brazil.

See footnotes at end of table.

Table 3.—Bolivia: Imports of mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1983	1984	Sources, 1984	
			United States	Other (principal)
INDUSTRIAL MINERALS				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc	--	1	1	
Grinding and polishing wheels and stones	39	41	1	Brazil 18; Peru 7; Norway 5.
Asbestos, crude	690	704	--	Brazil 448; Canada 253; France 2.
Boron materials:				
Crude natural borates	2	--		
Oxides and acids	2	1	--	All from West Germany.
Cement	7,871	5,087	244	Argentina 3,992; Chile 600; Brazil 251.
Chalk	2	10	1	Chile 9.
Clays, crude	704	247	86	Argentina 114; Brazil 45.
Diamond: Gem, not set or strung: value, thousands	$4	--	--	
Diatomite and other infusorial earth	5	375	370	West Germany 5.
Fertilizer materials: Manufactured:				
Ammonia	34	21	--	Brazil 16; West Germany 5.
Nitrogenous	4,790	7,347	75	Netherlands 5,086; West Germany 1,283; Brazil 586.
Phosphatic	--	802	--	Netherlands 470; Argentina 301; Brazil 31.
Potassic	6	112	--	Netherlands 111; Brazil 1.
Unspecified and mixed	156	5,916	5,900	Brazil 11; West Germany 4.
Graphite, natural	10	2	--	All from Brazil.
Lime	--	178	--	Brazil 133; Chile 45.
Magnesium compounds: Magnesite, crude	50	1	--	All from Brazil.
Nitrates, crude	--	15	--	All from Chile.
Phosphates, crude	2	--		
Pigments, mineral: Iron oxides and hydroxides, processed	45	81	--	West Germany 52; Belgium-Luxembourg 12; Argentina 8.
Precious and semiprecious stones other than diamond, synthetic: value, thousands	--	$4	--	All from France.
Pyrite, unroasted	--	10	10	
Salt and brine: value, thousands	$4	$1	--	All from Panama.
Sodium compounds, n.e.s.:				
Carbonate, manufactured	5,317	1,762	1,394	West Germany 363; Brazil 5.
Sulfate, manufactured	1,114	1,087	1	Peru 501; West Germany 361; Argentina 186.
Stone, sand and gravel:				
Dimension stone:				
Crude and partly worked	1,085	1,312	14	Brazil 1,251; Argentina 47.
Worked	--	4	--	All from Brazil.
Gravel and crushed rock	56	--	--	
Quartz and quartzite	27	2	--	All from Argentina.
Sand other than metal-bearing	140	56	14	Argentina 42.
Sulfur:				
Elemental: Colloidal, precipitated, sublimed	6	8	1	West Germany 5; Italy 1.
Sulfuric acid	594	85	--	Chile 60; Brazil 22; West Germany 6.
Talc, steatite, soapstone, pyrophyllite	18	14	--	Brazil 10; West Germany 4.
Other:				
Crude	43	37	--	Brazil 32; Ecuador 5.
Slag and dross, not metal-bearing	1	--		
MINERAL FUELS AND RELATED MATERIALS				
Asphalt and bitumen, natural	2,096	828	--	Brazil 484; Chile 344.
Carbon black	2	11	5	Argentina 4; Brazil 2.
Coal: All grades excluding briquets	960	72	--	All from Chile.
Coke and semicoke	258	154	--	Argentina 86; Colombia 38; Brazil 20.
Petroleum refinery products:				
Liquefied petroleum gas: value, thousands	--	$2	$2	
Gasoline, motor, 42-gallon barrels	102	68	17	Brazil 51.
Mineral jelly and wax do.	2,449	3,573	464	Argentina 2,983; West Germany 102.
Kerosene and jet fuel: value, thousands	--	$5	$5	
Distillate fuel oil, 42-gallon barrels	--	48,566	--	All from Brazil.
Lubricants do.	33,565	8,715	3,458	Brazil 3,591; Argentina 826.
Residual fuel oil do.	53	--		
Bitumen and other residues do.	103	--		
Bituminous mixtures do.	11,241	351	12	Brazil 327; Chile 12.

[1]Table prepared by H. D. Willis. Import data for 1984 were the latest available at the time of publication.
[2]Less than 1/2 unit.

COMMODITY REVIEW

METALS

Antimony.—The Bolivian antimony production was entirely by the private mining sector of which the medium-size mines produced 64% and the small-size mines, which includes the cooperatives, produced the remaining 36%. During 1987, Bolivia's antimony mine production increased by 4% over that of 1986 to 10,635 tons. Empresa Minera Unificada S.A. (EMUSA), operating the Chilcobija and Caracota Mines, is by far the largest producer of antimony concentrate, followed by Empresa Minera San Juan Ltda. and Empresa Minera Hermanos Bernal S.A., producer of antimony trioxide and antimony alloys at its Palala smelter in Tupiza, Potosi Department.

In September 1987, Laurel Industries of Cleveland, Ohio, the United States, made a tentative proposal to the Bolivian Government to construct an antimony trioxide smelter in Bolivia provided that there was an assured market for the output and two older antimony smelters in the country, which reportedly were operating below capacity. However, Laurel asserted that the quality of these plants' output did not meet Laurel's requirements.

Laurel was considering an association with EMUSA on this project. Bolivia has sufficient antimony reserves to supply the planned processing plant.

In 1987, the prices for clean antimony concentrates and antimony ore were on the rise. Consumers were reporting a lack of clean concentrates below $19 per ton, with some businesses booked as high as $19.75 for good Bolivian antimony. Bolivian lumpy ore of EMUSA origin had been sold at up to $23 per ton with some expectation of a $1 or $2 increase in the near future.

Chinese antimony, with its minimum 30 parts per million mercury and selenium impurity content, continues to trade at deep discounts to Bolivian and South African origin ores, although the Chinese are currently trying to push up the price for their best-quality concentrates to about $15 per ton.

Gold.—For many years prior to 1983, mining had been the principal contributor to Bolivian exports. Since then, oil and gas have edged mining into second place according to official figures. Within the mining field, tin has long been considered king, although gold, lead, silver, tungsten, and zinc have made important contributions, and until its price collapsed, tin was believed to account for 70% of the foreign exchange derived from mineral exports.

Gold has been given only passing mention in any discussion of Bolivian mining. Compared with silver and base metals, gold production has been, according to Government statistics, relatively insignificant.

Official gold production figures are inaccurate. They reflect the reported but not the actual production total and fail to account for the considerable quantities of gold that are regularly smuggled out of the country. Unofficial but more reliable estimates by industry watchers place yearly output near 20 tons (643,000 troy ounces). This puts the value of gold production in the same range as the export value of all other metals, aproximately $207 million.

Based on gold sold to BAMIN, the Ministry of Mines and Metallurgy reported that Bolivia's total gold production in 1987 was 88,585 troy ounces, an increase of 277% compared with that of 1986. The principal source of gold production in Bolivia continued to be 78 gold mining cooperatives operating in the goldfields of Guanay, Huayti, Mapiri, Teoponte, and Tipuani (north of the city of La Paz), which accounted for 82% of total production. The medium-size mining sector contributed 18% of the total output. In this sector, Inti Raymi S.A. has become the largest private gold producer in Bolivia with its open pit operation at La Joya near the city of Oruro. In 1987, Inti Raymi produced 15,458 troy ounces of gold or 98% of the medium-size mining sector's production. The U.S. Overseas Private Investment Corp. approved a loan to increase the production level to 4,000 tons of ore per day, which should bring the project into a world class mine category, a first for a hard-rock gold mine in Bolivia.

Lead, Silver, and Zinc.—Production of all three commodities was up substantially compared with that of 1986. Lead ore and concentrate increased 190% to 9,043 tons, silver was up 47%, and zinc was up 17%. Metallic lead, including alloys, output increased 10% compared with that of 1986. The medium-size mines sector was the dominant lead, silver, and zinc producer with its mines producing 72% of the lead, 52% of the silver, and 91% of the zinc. The major producers were Cía. Minera del Sur S.A. (COMSUR), Cía. Quioma S.A., and Cía. Minera Tiahuanacu Ltda. Most of the rest of the nonferrous output was by the small-size

mines and cooperatives.

COMIBOL, once the largest producer of all commodities, fell to the last category with 11% of the lead output, 28% of silver, and 7% of zinc.

An invitation issued in 1987 to prospective partners in Bolivia's much troubled Karachipampa lead-silver smelter failed to elicit any interest from smelters overseas. Despite the positive results of a feasibility study by Federal Republic of Germany consultants (Stolberg Consulting Engineers) and despite a vote of confidence from the Federal Republic of Germany Government itself in the form of a $15 millon loan, there appears to be little belief in industry circles that the plant can indeed operate economically. The Karachipampa smelter was opened officially in 1984 but operated only sporadically due to technical problems and a shortage of concentrate feed. The plant requires some 51,000 tons per year of lead-silver concentrates to produce the planned 22,000 tons per year of 99.98% refined lead and 196 tons per year of 99.92% silver. Hopes for a startup of the smelter seemed to fade at yearend, when mining officials recommended that legal proceedings be brought against those responsible for giving the Karachipampa smelter the construction approval.

Within the country, a number of old polymetallic deposits, mined in the past for their tin ores, have been developed to boost lead and silver output. Among these were the San José and San Vicente Mines. COMIBOL was also looking for mining partners for joint ventures of this kind.

During 1987, the number of medium-size mining companies that were members of the Medium Miners National Association decreased from 24 to 18 owing to shutdowns due to a depressed economic situation. Only one new mining company was admitted to the association, Empresa Minera Maragua Ltda., another lead, silver, and zinc producer.

The International Finance Corp. (IFC) of the United States was investing $1.2 million of a total of $4.5 million in a project to recover silver from old mine dumps near the El Cerro Rico de Potosí. Low-cost heap leaching will be used by Cia. Minera Concepcion S.A. an affiliate company of COMSUR. The project is expected to produce about 727,000 troy ounces of silver per year for export. This will be the first IFC-approved investment in Bolivia since 1978.

ASARCO Incorporated of the United States sold its Bolivian mining interest to COMSUR for an undisclosed amount. The sale of the Cerro Grande and Berenguela tin mines and the Quioma lead and zinc mine was completed in mid-August. Quioma was reopened in January 1987 after a shutdown of several months in 1986, but operations at Berenguela remained suspended.

Tin.—National tin output declined 22.4% from that of 1986 to about 8,000 tons, and COMIBOL production of tin barely reached 384 tons, the lowest output of tin in the past 35 years.

The collapse of the International Tin Council price support has virtually disintegrated an industry that in the past earned much of the country's foreign exchange revenue. The new leader in tin production in Bolivia was the medium-size mining sector with 68% of the total production. In second place were the small-size mines and cooperatives with 27%, while COMIBOL accounted for the remaining 5%. The decline of tin production in Bolivia was due to the continued depressed prices for tin in the international market. This resulted in the closure of several unprofitable tin mines within COMIBOL and in the private sector. There have also been serious labor conflicts as a result of the massive layoffs. Bolivia's tin is derived from hard-rock underground mines, which is expensive compared with alluvial tin dredging operations in other parts of the world, such as Brazil, Indonesia, and Malaysia.

COMIBOL's plans for increasing tin output depend largely on the success of new investments and the rehabilitation of some tin and polymetallic mines during the restructuring program announced in 1986 and put into effect in 1987.

COMIBOL was divided into the Mining and Metallurgical Divisions with mining companies placed under five regional subsidiaries. With funds from the Bolivian Government and multilateral lending organizations, COMIBOL planned a short-term rehabilitation program for seven mines and investment in reserve development and modernization of installations. By July 1987, the San José (tin-silver-lead), San Vicente (tin-silver-zinc), and Sante Fé (tin-lead-silver) Mines were back in production following rehabilitation of milling facilities and outlining of significant ore reserves. Also, the Caracoles group of tin mines—Argentina and Pacuni—were scheduled to be producing 37 tons per month of tin in concentrates by December 1987. Most recently Huanuni, the country's richest hard-rock tin mine has been rehabilitated to

process 1,000 tons per day of ore grading 1.7% tin.

Initial output was scheduled to be 200 tons per month of tin concentrate to expand to 500 to 600 tons by December 1988 with an average grade of 40% to 50% tin. One-half of the output was to go to the Vinto metallurgical complex. The next stage of the program was to include the rehabilitation of the Colquiri Mine, with an investment of $3.8 million. COMIBOL was to assist with $1.4 million, $1.0 million in the form of a loan from the World Bank and $1.4 million from the Vinto smelter in return for promised future concentrate supply. The rehabilitation plan for COMIBOL's smelting operations at Vinto were approved in 1986. Annual losses were running at $1.5 million at the smelter, which has a combined capacity of 30,000 tons per year in its high- and low-grade sections. The smelter has always operated below capacity, and in 1986-87 suffered from shortages of concentrate feed. A Federal Republic of Germany consulting firm was conducting a $10 million study to reduce the smelter's capacity in the high-grade section to 6,000 tons per year and convert its fuel from oil to natural gas. The low-grade section would be closed indefinitely.

Vinto has, during recent years, been unable to compete with foreign companies for concentrates, but now has $10 million available plus quantities of tin metal stocks that can be sold or traded for concentrates. At yearend, the tin production from the cooperatives, now working the Siglo XX tin mine at Catavi in Bolivia, was reported to have stabilized at about 400 tons per month. The cooperatives indicated that there were sufficient proven reserves to maintain this rate of output for 10 to 15 years. Present production is several times more than that achieved by COMIBOL (about 50 tons per month) during the months before COMIBOL suspended operations. This is typical of the mines that COMIBOL has relinquished to cooperatives.

Tungsten.—Bolivia's production of tungsten concentrates, heavily dependent on international metal prices, declined by almost 42% compared with that of 1986 to 638 tons of metal content. COMIBOL's production dropped from 77 tons of metal content in 1986 to zero, because of the closure of all mines due to severe ore depletion and high operating costs. Output of the medium-size mining sector decreased 30% compared with that of 1986, and production by the small-size mining sector declined by 48% below that of 1986 to 240 tons of metal content. During 1987, the International Mining Co. (IMCO) continued to be the largest tungsten producer in the country, followed by Empresa Minera San José de Berque, which has become an important tungsten producer in Bolivia with its Esmoraca, Española, La Argentina, and Pueblo Viejo Mines in Sud Chichas, Potosí Department.

INDUSTRIAL MINERALS

Industrial minerals have been traditionally of minor importance in Bolivia, although the need for them has increased tremendously during the past 15 years because of expanded markets. Bolivia has many undeveloped and various types of industrial mineral deposits, of which only a few have been studied. Such industrial mineral deposits occur widely throughout the country. It appears that Bolivia's failure to develop such deposits as quickly as some of its neighbors, especially Argentina and Chile, will limit its ability to take advantage of the opportunities. Bolivia, with huge lithium brine reserves at the Salar de Uyuni, faces the same market dilemma as the Peruvian saltpeter entrepreneurs did with iodine in 1874.

Lithium and Potassium.—Bolivia's options for its enormous brine reserves, rich in lithium, boron, potassium, and magnesium, have been reported in the technical literature to have only one processing possibility—solar pond production of a massive quantity of muriate, a smaller quantity of boric acid, and a tiny amount of lithium. With the low evaporation rates prevalent at the 4,000-meter-high Salar de Uyuni and freight rates to the Pacific Ocean that are greater than the shipside price of potassium chloride, it appears economical to develop these minerals. However, Bolivia has a small salt lake with heated surface brines containing 2.6 grams per liter of lithium located within 30 kilometers of a geothermal source that is currently being deep drilled with $13 million of Italian Government funding. Preliminary drilling indicated steam potentially clean enough for generator turbine use and adequate for use in multiple-stage vacuum evaporators. With these energy sources, a low-cost lithium carbonate production plant could be installed promptly at this location. The cashflow generated by low-cost lithium sales could be used to fund development of the large rich core of the Salar de Uyuni, where brines containing over 3 grams per liter of

lithium can be processed. This salt marsh, with 5.5 million tons of lithium brine reserves, is 150 kilometers from two geothermal sources and the same distance from natural gas pipelines.

Sulfur.—A shortfall in worldwide sulfur supply is likely to develop over the next 5 to 10 years, and Bolivia should be well positioned to serve the Latin America market. One of the more interesting applications for sulfur is as a direct-application fertilizer. In fact, Bolivia's central location on the South American Continent opens up the possibility of the country's becoming a regional supplier of many agricultural minerals, including sulfur, potash, gypsum, liming materials, and various micronutrients (especially boron, manganese, and zinc).

MINERAL FUELS

Natural Gas.—Output of natural gas increased slightly from that of 1986. Yacimientos Petroliferos Fiscales Bolivianos (YPFB) Rio Grande gasfield continued to be Bolivia's largest natural gas producer, followed by Occidental Bolivian Inc.'s Porvenir Gasfield. Of the total production of natural gas, 63% was produced from YPFB gas fields and 37% by private contractors, Occidental and Tesoro Bolivia Petroleum Co.

Bolivia's domestic consumption of natural gas continued to be minimal at 9.7 billion cubic feet, 8.6% over that of 1986. The major consumers of natural gas in 1987 were the National Electrical Power Co. (ENDE), which used more than 50% of the national consumption, and the Bolivian cement industry.

Future increases in domestic consumption of natural gas are expected upon completion of the new 457-kilometer, 10- to 34-inch gas pipeline from Rio Grande, Santa Cruz, to Huaynacota-Parotani, Cochabamba. Construction of this gas pipeline started in December 1986 by Protexa S.A. of Mexico and should be completed by December 1988. Eighty-four percent of the pipeline was constructed in 1987. This pipeline will be linked to an old 164-kilometer, 6- to 34-inch pipeline from Cochabamba to Oruro and to a 208-kilometer pipeline constructed in 1986 from Oruro to La Paz. The pipeline will deliver 52 million cubic feet per day of natural gas in the Santa Cruz-Cochabamba section, 24 million cubic feet in the Cochabamba-Oruro section, and 15 million cubic feet in the Oruro-La Paz section.

The cost of the construction plus the conversion of the old pipeline was estimated at $98.6 million. The project was financed by the Inter-American Development Bank's (IDB) loan of $69 million and the remainder by YPFB.

Argentina continued to be Bolivia's sole foreign customer for natural gas. In 1987, Argentina paid cash for 40% of such imports and issued trade credits, which were mostly unused, for the remainder. After September 1987, cash was paid for 80% of imports, although the price received for natural gas was reduced by 11.5%.

Exports of natural gas to Argentina decreased 4.2% to 74.9 billion cubic feet, compared with those of 1986. Revenues from natural gas exported to Argentina decreased 30.4% below that of 1986 to $248.6 million. The reduction in revenues was due to the price reduction agreement made between Bolivia and Argentina in September 1987, this price was $3.05 per million British thermal units (Btu), 17.6% lower than the price set from January to December 1986, with an indexed price, based on a mathematical formula, used until the conclusion of the contract in 1992.

Of the natural gas produced in Bolivia, 46.4% was exported to Argentina, 6.0% was consumed domestically, 37.9% was reinjected into the gasfields, 3.4% was vented or flared, 4.4% was consumed as fuel by YPFB, and the remainder was consumed in miscellaneous uses.

Officials of the Ministry of Energy and YPFB were preparing for a technical meeting to be held in Brazil in early 1988 to define volume, price, financing, and construction procedures of a natural gas sales agreement to be presented at a meeting between the two Governments to be held in La Paz, Bolivia, sometime in July or August 1988.

Brazil expressed interest in buying 108 million cubic feet of natural gas per day from Bolivia to be used in its border State Matto Grosso. A Petróleo Brasileiro S.A. (PETROBRÁS) gas discovery and lower liquid fuel prices virtually closed the São Paulo market for Bolivian natural gas.

The idea of establishing an industrial center in Corumba, Brazil, was suggested by the U.S. Government, who reportedly expressed concern over the economic situation of Bolivia. The proposed industrial complex in Corumba, now under study, would include installation of a steel plant with an annual capacity of 1.8 million tons. It would also include a fertilizer plant and two thermoelectric plants, which would use Bolivian gas.

The U.S. Government suggestion report-

edly received immediate support from the IDB, which was prepared to help finance the industrial complex as long as it was built in Brazil and principally exported to Bolivia. Preliminary studies suggest that cost, including the 600 kilometers of the pipeline from Santa Cruz, Bolivia, to Corumba, Brazil, could total $1 billion. Bolivia officials will propose building a pipeline to provide Paraguay with natural gas in exchange for soybeans, cotton fiber, and beef. Paraguayan officials say there is high-level interest in the project, which, if approved, might be an offshoot of the existing gas pipeline between Camiri, Santa Cruz, to Argentina.

The Enron Corp., the largest natural gas pipeline company in the United States, owns Belco Petroleum Co., whose properties in Peru were expropriated by the Peruvian Government. Company officials were talking with the Bolivian Government about a possible $400 million investment to develop gasfields that belong to YPFB and to construct jointly with the State Electric Power Co., a gas thermal power generating plant in Santa Cruz. Bolivia's quantified and certified natural gas reserves as of December 31, 1987, were 4.1 trillion cubic feet.

Petroleum.—Production of crude oil and condensate remained basically unchanged compared with that of 1986. The total average daily production increased after a 10-year downward trend to 18,878 barrels in 1987 from 17,587 barrels in 1986.

YPFB acted as the operating unit of the sector, performing the role of an integrated oil company from exploration to development of oilfields and gasfields. It was also the sole refiner, transporter, and retailer of all finished products in the country. YPFB may contract specialized petroleum service companies. The current petroleum law does not permit joint-venture operations between YPFB and other parties.

In 1987, YPFB received requests from several oil companies for geological data about the Bolivian Altiplano and other areas. Phillips Petroleum Co. signed an information exchange and natural assistance agreement with YPFB. Phillips was interested in the areas of Roboré and Tucavaca (130 kilometers east of Santa Cruz). Shell Exploration NV of the Netherlands was interested in the Bolivian Altiplano and has presented a proposal to YPFB. Other companies that have expressed interest in the Bolivian oil industry were Union Oil Co. of California, Amoco Petroleum Co., and Petro-Canada. Future entry of companies as operating contractors will depend upon a well-defined policy and contractual terms.

During the year, YPFB ran 1,840 kilometers of exploration seismic lines, 32% less than in 1986, and conducted 24,000 meters of drilling in 10 new exploratory oil wells, 82% more than in 1986. No exploration drilling was recorded by the two foreign oil companies' contractors. Of the exploratory wells completed in 1987, the Villamontes X-1 and X-4 and the Víbora X-1 wildcat holes were shallow discovery oil wells. The Villamontes X-2 and Itaguazurenda X-2 wildcat holes turned out to be oil producers. All of these oil wells were drilled in the southern and central districts of YPFB. Total Bolivian oil reserves (crude oil plus lease condensate), as of December 31, 1987, were 125.5 million barrels of oil, of which 111 million barrels or about 88% were YPFB's reserves and the remainder was contractors' reserves. These reserves are sufficient for Bolivia's oil consumption for the next 14 years.

The high probability of finding natural gas instead of crude oil, the limited natural gas export market, and current oil market conditions reduce Bolivia's attractiveness for exploration by foreign companies. There also have been delays in revising the contracts of Occidental and Tesoro and in resolving payment issues. These factors have made it difficult for the Government to attract new exploration capital. Nevertheless, some companies have signed information exchanges and mutual assistance agreements with YPFB.

[1]Physcial scientist, Division of International Minerals.

[2]Where necessary, values have been converted from Bolivianos ($b) to U.S. dollars at the rate of $b2.22 = US$1.00.

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